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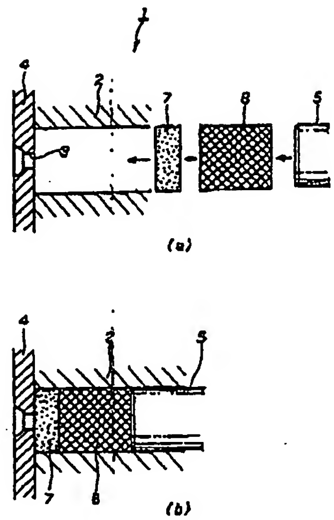
(54) [Title of the Invention] Method of manufacturing a clad material using an extrusion method

(57) [Abstract]
[Object] To provide a method of manufacture in which the thickness of the shell can be altered easily and, moreover, in which a high quality of manufactured product can be maintained.
[Constitution] A clad material comprising a shell and core is manufactured by the packing of a shell-forming first billet 7 and a core-forming second billet 8 in sequence in the extrusion direction into a container 2, and the extrusion of the second billet 8 using a stem 5. The thickness of the shell can be altered by altering the compressive force acting on the second billet 8 at this time.



[Scope of the Patent Claims]

[Claim 1] Method of manufacturing a clad material in which a compressive force acts by way of a stem on two types of billets arranged in a container to extrude them through a bearing, which method of manufacturing a clad material using an extrusion method is characterized in that a first billet for forming the shell of the clad material is arranged on the dié side of the container and a second billet for forming the core thereof is arranged with connection to the first billet, wherein the clad ratio is altered by altering the abovementioned compressive force.

[Claim 2] Method of manufacturing a clad material using an extrusion method according to Claim 1, characterized in that the abovementioned compressive force is determined on the basis of at least one condition selected from bearing length equivalent to the die hole, choke angle equivalent to the tilt angle where a bearing of a tapered shape is used, extrusion ratio calculated as the cross-sectional area of the billet/cross-sectional area of the manufactured product, and extrusion speed.

[Detailed Description of the Invention]

[0001]

[Field of Industrial Utilization] The present invention relates to improvements to the method of manufacturing a clad material using an extrusion method.

[0002]

[Prior Art] The manufacture of clad materials, which constitute a laminate of materials of different properties, involves the lamination of either a joining material, corrosion-resistant material or shake-resistant material or the like on a surface material with the objective of improving the functional characteristics of the member material. A wide variety of methods of

manufacture thereof have actual application and one of these methods is an extrusion method.

[0003] Techniques available for the manufacture of a clad material using an extrusion method include the "Method of manufacture of a solid clad material" disclosed in Japanese Unexamined Patent Application No. Heisei 3-138017. This technique, in which extrusion is performed employing a columnar core-forming billet in which a projecting insert protrusion is integrally formed in the center of the front-end surface and a shell-forming billet of a ring shape through which the insert protrusion is inserted and involves the use of a solid die in which the rear-end surface is formed as a recessed conical surface, constitutes a technique in which the thickness of the shell in the longitudinal direction can be made uniform by, utilizing the tilt of the conical surface of the rear end of the die, quantifiably moving the constituent member metal to a moulding hole.

[0004]

[Problems to be Solved by the Invention] However, because the above-described technique involves the utilization of the tilt of the die conical angle a lapping of the shell is liable to occur and, where defects such as cracks occur in the shell, these are produced as streaks (crease cracks) formed in the clad section, that is to say, in the shell. To prevent this a process for the removal thereof that involves, for example, a fixed level of machining of the surface must be performed on the shell. Accordingly, processing such as this lowers the quality of the clad material and results in an increase in costs. Furthermore, the shape of the billets used in the above-described technique is complex and the degree of freedom of shape thereof is restricted.

[0005] In addition, in the above-described technique, which is a technique that produces a shell of uniform thickness, there is no reference at all made to a technique for altering the thickness of the shell. However, a need has arisen in recent years to be able to, as required, alter the clad ratio as defined by the thickness ratio of the shell, and there is a subsequent need for development in the research thereof. Thereupon, the object of the present invention lies in the provision of a technique in which a simplification of billet shape can be achieved and in which alteration of clad ratio is possible.

[0006]

[Means to Solve the Problems] The present invention, which obviates the above-noted problems, is characterized in that, in a method of manufacturing a clad material in which a compressive force acts by way of a stem on two types of billets arranged in a container to extrude them through a bearing, which method of manufacturing a clad material using an extrusion method is characterized in that a first billet for forming the shell of the clad material is arranged on the die side of the container and a second billet for forming the core thereof is arranged with connection to the first billet, wherein the clad ratio is altered by altering the abovementioned compressive force.

[0007] The present invention is further characterized in that the abovementioned compressive force is determined on the basis of at least one condition selected from bearing length equivalent to the die hole, choke angle equivalent to the tilt angle where a bearing of a tapered shape is used, extrusion ratio calculated as the cross-sectional area of the billet/cross-sectional area of the manufactured product, and extrusion speed.

[0008]

[Action] Figures 1(a) and (b) represent general drawings of the method of manufacture of a clad material using an extrusion method pertaining to the present invention, wherein an extrusion device 1 for embodying the method of the present invention comprises a container 2, a die 4 comprising a bearing 3, and a plunger or stem 5. In (a) thereof, a shell-forming first billet 7 and a core-forming second billet 8 are packed in sequence into the container 2. In (b) thereof, the packed billets 7, 8 are extruded by a stem 5.

[0009] Figures 2(a) to (d) are process diagrams of the manufacture of the clad material pertaining to the present invention. In (a) thereof, part of the first billet 7 is squeezed out through the bearing 3 by the pressing of the stem 5, and the center of the front surface of the second billet 8 is gradually expanded forward by this same amount. In (b) thereof, a substantial part of the second billet 8 is thrust into the center of the first billet 7. The arrows in the diagrams provide a schematic indication of the flow of the metal. (c) thereof illustrates the regular state in which a clad material 9 is extruded through the bearing 3 when the shell produced by the first billet 7 covers the core produced by the second billet 8. (d) thereof illustrates the state in which this operation is continued further and the amount of first billet 7 and second billet 8 that remain has decreased. That is to say, this diagram illustrates the operation that is continued until one of either the billets 7 or 8 are used up.

[0010] As is described below, the inventors of the present invention and their associates confirmed through tests that there is a notable difference between the

method of the present invention and hitherto employed methods. This difference is predicated upon the hypothesis logically explained below. Figures 3(a) and (b) are diagrams providing a logical explanation of the method of the present invention wherein, based on the regular state of abovementioned Figure 2(c), a first billet 4 has a triangular cross-sectional shape. This cross-section is referred to as the "dead metal" and the shape thereof is determined by the properties of the material. Thereupon, in Figure 3(a), taking the tilt angle of the cross-section 4a of the first billet 4 as θ, the extrusion force along the sloping surface 4a as N, and the compressive force of the stem as P, the following relational expression is established. The tilt angle θ constitutes the angle at which, depending on the materials, slide is likely to occur.

$N = P \cdot \cos\theta$ (1)

[0011] In Figure 3 (b), it is assumed that part of the first billet 7 is pulled away by the shear force of the second billet 8 and, accordingly, taking the critical shear stress at this time as τ and the cross-sectional area of the section pulled away along the sloping surface 4a by the force N as A, the following equation is established. It should be noted that the critical shear stress τ is a value determined by, amongst other things, the composition of the material and the temperature.

$N = \tau \cdot A$ (2)

In the above-noted equations (1) and (2), cosθ and τ are established as constants under said conditions. The following equations are additionally established from equation (1) and equation (2):

$P \cdot \cos\theta = \tau \cdot A$ (3)

$A = (\cos\theta/\tau) \cdot P$ (4)

Because ($\cos\theta/\tau$) in equation (4) is a constant, A can be altered by altering P and the thickness of the shell can be altered by altering A. It should be noted that this explanation constitutes a hypothesis only and supporting evidence for said is provided by the later-described test results.

[0012] A specific method for the alteration of P was examined in accordance with the above-described hypothesis. Figures 4(a) to (d) are diagrams illustrating specific examples of the method of manufacture of the present invention and a comparative example thereto, wherein in (a) thereof, which constitutes the comparative example, the bearing 3A used was a straight bearing of diameter d and length l. (b) illustrates a first practical example, wherein the length of the bearing 3B, which is taken as L, is significantly larger than the length of the bearing of the comparative example. By virtue of the fact that the resistance is greater, if it is assumed that the extrusion speed is unaltered the extrusion force P will increase and, as a result, the thickness of the shell will be increased. (c) illustrates a second practical example thereof, wherein the diameter of the bearing 3C, which is taken as D, is smaller than the comparative example. By virtue of the fact that the resistance is greater, if it is assumed that the extrusion speed is unaltered the extrusion force P will increase and, as a result, the thickness of the shell will be increased. Taking the diameter of the container as a constant, the extrusion ratio is altered in this case as a result of the alteration of the diameter of the bearing 3C.

[0013] (d) illustrates a third practical example thereof in which the bearing 3D used was of a tapered shape of which the tilt angle thereof is referred to as the choke

angle and in which a choke angle α was established as appropriate. The choke angle of the comparative example is 0 but, by virtue of the fact that the resistance is greater when the choke angle α as indicated in the diagram is established because the bearing 3D is a pointed shape, if it is assumed that the extrusion speed is unaltered the extrusion force P will increase and, as a result, the thickness of the shell will be increased. In addition, in a structure (a) which constitutes a fourth practical example, by virtue of the fact that, if the movement speed of the stem is increased, the resistance is greater, the extrusion force P increases and, as a result, the thickness of the shell will increase. In this case, the extrusion speed is altered.

[0014]

[Practical Examples] A description of the practical examples of the present invention is given below. It should be noted that the bearing refers to a section within a hole provided in the die in which the actual moulding of the material occurs. In addition, as is described above, the extrusion ratio constitutes a value obtained by dividing the cross-sectional area of the billets by the cross-sectional area of the manufactured product. Figure 5 is a graph that pertains to the first practical example of the present invention in which the horizontal axis refers to the bearing length and the vertical axis refers to the clad ratio (%). The clad ratio (%) is defined as (shell thickness (mm) ÷ clad material radius (mm)) x 100.

First practical example: As is explained by the abovementioned Figure 4(b), the bearing length was altered in stages and the clad ratio (%) was examined at these times. The testing conditions thereof are outlined

in a table provided in the lower-half section of the diagram.

Shell-forming first billet	Aluminium 6063
Core-forming second billet	Aluminium 4032
Billet temperature	450°C
Choke angle	0°
Extrusion ratio	24
Extrusion speed	30m/min (stem speed)

As is clear from the graph, the shell thickness can be altered by altering the bearing length. Notably, the bearing length directly affects the moulding of the material and linearly increases the thickness of the shell. However, if the bearing length is excessively increased contact friction will occur and, accordingly, there is a subsequent fear that this frictional force will fracture the shell. Thereupon, the upper limit adopted for the bearing length is of the order of 15mm.

[0015] Figure 6 shows a graph that pertains to the second practical example of the present invention in which the horizontal axis refers to the extrusion ratio and the vertical axis refers to the clad ratio (%).

Second practical example: As is explained by the abovementioned Figure 4(c), the extrusion ratio was altered in stages and the clad ratio (%) was examined at these times. The testing conditions thereof are outlined in a table provided in the lower-half section of the diagram.

Shell-forming first billet	Aluminium 6063
Core-forming second billet	Aluminium 4032
Billet temperature	450°C
Bearing length	5mm
Choke angle	0°
Extrusion speed	400mm/min (clad material speed)

As is clear from the graph, the shell thickness can be altered by altering the extrusion ratio. However, if the extrusion ratio is enlarged too much an increase in the deflection of the metal mould and, in particular, the die will occur which will affect the dimensional precision of the manufactured product. Thereupon, the upper limit adopted for the extrusion ratio is 50 for a large billet and 100 for a small billet.

[0016] Figure 7 is a graph that pertains to the third practical example of the present invention in which the horizontal axis refers to the choke angle and the vertical axis refers to the clad ratio (%).

Third practical example: As is explained by the abovementioned Figure 4(d), the choke angle was altered in stages and the clad ratio (%) was examined at these times. The testing conditions thereof are outlined in a table provided in the lower-half section of the diagram.

Shell-forming first billet	Aluminium 6063
Core-forming second billet	Aluminium 4032
Billet temperature	450°C
Bearing length	3mm
Extrusion ratio	24
Extrusion speed	30m/min (stem speed)

As is clear from the graph, the shell thickness can be altered by altering the choke angle. However, if the choke angle exceeds 0.5° the thickness of the shell that is produced will not be very thick. Conversely, because of difficulties achieving precision processing if the choke angle is 0.5° or less, a bearing length of 2 to 3mm at 10 to 15° is preferred.

[0017] Figure 8 is a graph that pertains to the fourth practical example of the present invention in which the horizontal axis refers to the extrusion speed and the vertical axis refers to the clad ratio (%).

Fourth practical example: The extrusion speed was altered in stages and the clad ratio (%) was examined at these times. Alteration of the extrusion speed was achieved by simply altering the movement speed of the stem. The testing conditions thereof are outlined in a table provided in the lower-half section of the diagram.

Shell-forming first billet	Aluminium 6063
Core-forming second billet	Aluminium 4032
Choke angle	0°
Billet temperature	450°
Bearing length	5mm
Extrusion ratio	24

As is clear from the graph, the shell thickness can be altered by altering the extrusion speed. However, if the extrusion speed is too high the shell thickness does not necessarily increase by that same amount. Conversely, there is a marked generation of heat produced as a result of friction with the bearing and, accordingly, a subsequent fear that a deterioration of the shape of the shell will occur. Thereupon, the upper limit for the extrusion speed for aluminium 6063 is set at 60m/min.

[0018] The shell thickness should be altered by the use of one or a plurality thereof in combination of the above-described practical examples. Of these, because the method for alteration of the bearing length affords independent control of both the productivity and the finishing precision, practical example 1 is most effective and, accordingly, it is desirable that practical example 1 be used either independently or that practical example 1 be used in combination with the other practical examples. In addition, if the billet temperature is altered, the resistance force on the bearing changes and, in accordance therewith, the compressive force changes. Thereupon, the billet ratio

can be altered by alteration of the billet temperature independently or in combination with the above-described causative factors.

[0019]

[Effect of the Invention] The present invention, which is based on the above-described configuration, affords the following effects. Because Claim 1 is characterized in that, in a method of manufacturing a clad material in which a compressive force acts by way of a stem on two types of billets arranged in a container to extrude them through a bearing, a first billet for forming the shell of the clad material is arranged on the die side of the container and a second billet for forming the core thereof is arranged with connection to the first billet, wherein the clad ratio is altered by altering the abovementioned compressive force, there is no need for the administration of special processing on the billets and, accordingly, production costs can be decreased. Moreover, because the thickness of the shell can be altered by altering the compressive force acting on the second billet, a wide range of shell thickness demands can be met easily.

[0020] Because Claim 2 of the present invention is characterized in that the abovementioned compressive force is determined on the basis of at least one condition selected from bearing length equivalent to the die hole, choke angle equivalent to the tilt angle where a bearing of a tapered shape is used, extrusion ratio calculated as the cross-sectional area of the billet/cross-sectional area of the manufactured product, and extrusion speed, the thickness of the shell can be altered easily and, because the manufacture thereof can be implemented extremely efficiently, the related

manufacturing operation is simple and the burden on the operator is reduced.

[Brief Description of the Diagrams]

[Figure 1] is a general drawing of the method of manufacturing a clad material using an extrusion method pertaining to the present invention;

[Figure 2] is a process diagram of the manufacture of the clad material pertaining to the present invention;

[Figure 3] is a diagram for logically explaining the method of the present invention;

[Figure 4] is a diagram that illustrates specific examples of the method of the present invention and a comparative example thereto;

[Figure 5] is a graph pertaining to a first practical example of the present invention;

[Figure 6] is a graph pertaining to a second practical example of the present invention;

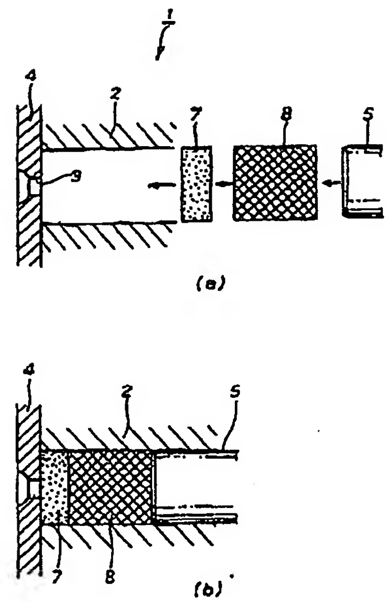
[Figure 7] is a graph pertaining to a third practical example of the present invention; and

[Figure 8] is a graph pertaining to a fourth practical example of the present invention;

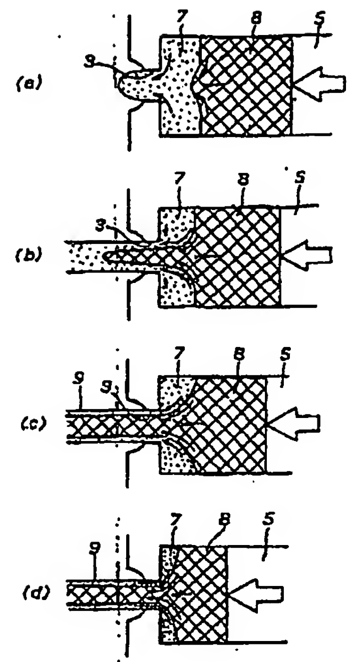
[Explanation of Symbols]

1 Clad material extrusion device, 2 Container, 3 Bearing, 4 Die, 5 Stem, 7 Shell-forming first billet, 8 Core-forming second billet, 9 Clad material, P Compressive force

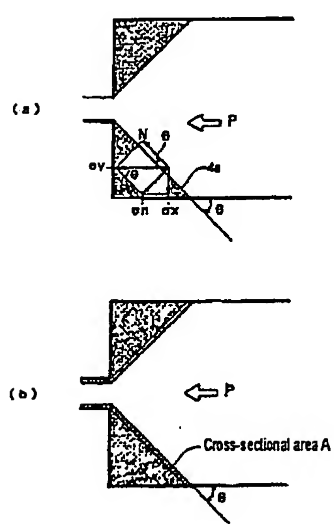
[Figure 1]



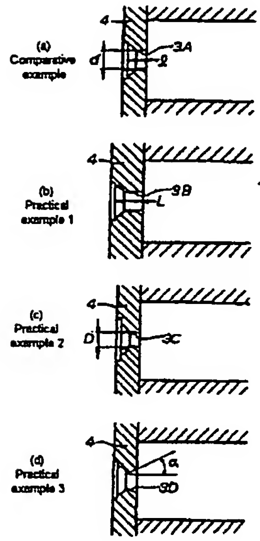
[Figure 2]



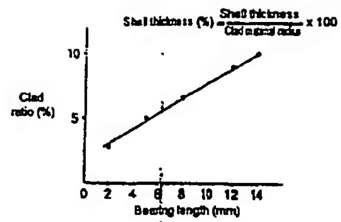
[Figure 3]



[Figure 4]

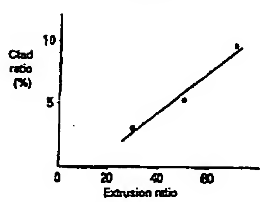


[Figure 5]



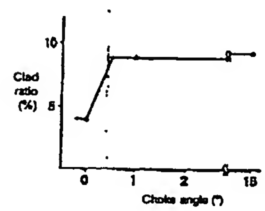
	Practical Example 1
Shell-forming first billet	Aluminium 6063
Core-forming second billet	Aluminium 4032
Billet temperature	450°C
Bearing length	Horizontal axis of above-noted graph
Choke angle	0°
Extrusion ratio	24
Extrusion speed	30m/min

[Figure 6]



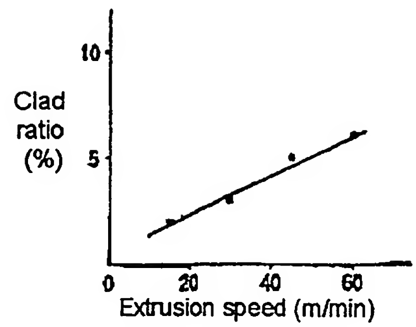
	Practical Example 2
Shell-forming first billet	Aluminium 6063
Core-forming second billet	Aluminium 4032
Billet temperature	450°C
Bearing length	5mm
Choke angle	0°
Extrusion ratio	Horizontal axis of above-noted graph
Extrusion speed	400mm/min

[Figure 7]



	Practical Example 3
Shell-forming first billet	Aluminium 6063
Core-forming second billet	Aluminium 4032
Billet temperature	450°C
Bearing length	5mm
Choke angle	Horizontal axis of above-noted graph
Extrusion ratio	24
Extrusion speed	30m/min

[Figure 8]



	Practical Example 4
Shell-forming first billet	Aluminium 6063
Core-forming second billet	Aluminium 4032
Billet temperature	450℃
Bearing length	5mm
Choke angle	0°
Extrusion ratio	24
Extrusion speed	Horizontal axis of above-noted graph

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damages caused by the use of this translation.
1.This document has been translated by computer. So the translation may not reflect the original precisely.
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3.In the drawings, any words are not translated.

TECHNICAL FIELD

[Industrial Application] This invention relates to amelioration of the manufacture approach of the clad plate by the extrusion method.

EFFECT OF THE INVENTION

[Effect of the Invention] This invention demonstrates the following effectiveness by the above-mentioned configuration. Claim 1 is characterized by changing a clad ratio by making compressive force act on two kinds of billets allotted in the container through a stem, allotting the 1st billet which serves as epidermis of a clad plate at the dice side in a container in the manufacture approach of the clad plate extruded from bearing, allotting the 2nd billet which is connected [billet / this / 1st] and serves as a core part, and changing said compressive force. Since it is, there is no need of performing processing according to rank to a billet, and a production cost can be lowered. In addition, since the thickness of epidermis is changed by changing the compressive force which acts on the 2nd billet, it responds to various skin-depth demands simply.
[0020] Since it can change the thickness of epidermis easily since claim 2 set up compressive force by at least one chosen from the choke angle which the die length of the bearing equivalent to a die hole and bearing taper off, and is equivalent to the tilt angle in the case of be a configuration , the extrusion ratio computed with the billet cross section / product cross section , and the extrusion rate , and manufacture can carry it out very efficiently , fabrication operation becomes easy and an operator's burden becomes light .

PRIOR ART

[Description of the Prior Art] A clad plate is the layered product of the ingredient with which properties differ, and is manufactured for the purpose of raising the functional characteristic of a member by carrying out the laminating of a jointing material for corrugated fibreboard, corrosion-resistant material, the vibration resistance material, etc. to a front face. Various utilization is carried out at the manufacture approach, one approach in it extrudes, and it is law.
[0003] JP,3-138017,A "the manufacture approach of a solid clad plate" is released to the technique which extrudes a clad plate and is manufactured by law. This technique performs extrusion by the solid die by which the back end side was formed in the center of a front end side in the concave conical surface using the billet for core part formation of the shape of a cylinder in which the projected part for fitting of the letter of a protrusion was really formed, and the billet for epidermination of the shape of a ring by which fitting is carried out to this projected part for fitting. It is the technique of telling a longitudinal direction that the thickness of epidermis can do uniformly, by moving configuration member ****** to a shaping hole quantitatively using the inclination of the conical surface of the dice back end.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, since it uses the inclination of dice ****, the above-mentioned technique tends to involve in epidermis, and when defects, such as a crack, are shown in epidermis, it will produce a streak (****), the part, i.e., the epidermis, by which the clad was carried out. Moreover, in order to prevent it, it is necessary to carry out removal processing of the epidermis by constant-rate cutting etc. from a front face. Therefore, it is the cause of deterioration of the quality of a clad plate, or a cost rise. Furthermore, with the above-mentioned technique, the configuration of a billet is complicated and the degree of freedom of a configuration is restricted.
[0005] Moreover, the above-mentioned technique is a technique which makes thickness of epidermis uniform, and has not mentioned the technique of changing the thickness of epidermis. However, it is necessary to change the clad ratio which shows the thickness rate of epidermis if needed, and to also advance this research in recent years. Then, the purpose of this invention is to attain the simplification of the configuration of a billet and offer the technique which can change a clad ratio.

MEANS

[Means for Solving the Problem] It is characterized by to change a clad ratio by allotting the 2nd billet which this invention allots the 1st billet which serves as epidermis of a clad plate at the dice side in a container in the manufacture approach of the clad plate which compressive force is made to act on two kinds of billets allotted in the container through a stem, and is extruded from bearing, and connects [billet / this / 1st] it in order to solve the above-mentioned technical problem, and serves as a core part, and changing said compressive force.
[0007] Said compressive force is characterized by being set up by at least one chosen from the choke angle which the die length of the bearing equivalent to a die hole and bearing taper off, and is equivalent to the tilt angle in the case of being a configuration, the extrusion ratio computed with the billet cross section / product cross section, and the extrusion rate.
[Function] Drawing 1 (a) and (b) are the principle Figs. of the manufacture approach of the clad plate by the extrusion method concerning this invention, and the extrusion equipment 1 for enforcing this invention approach consists of a container 2, a die 4 which formed bearing 3, and a plunger or a stem 5. By (a), a container 2 is loaded with the 1st billet 7 for epidermis, and the 2nd billet 8 for core parts at this order. The billets 7 and 8 with which it loaded by (b) are pressed by the stem 5.
[0009] Drawing 2 (a) - (d) is the production process Fig. of the clad plate concerning this invention. By having been pushed by the stem 5 by (a), a part of 1st billet 7 is protruded from bearing 3, and, only in the part, the center of a front face of the 2nd billet 8 bulges to the front gradually. By (b), a part of 2nd billet 8 advances into the core of the 1st billet 7 greatly. An arrow head shows the flow of metal notionally among drawing. (c) shows a steady state and the clad plate 9 which the epidermis by the 1st billet 7 covered to the core part by the 2nd billet 8 is extruded from bearing 3. An activity progresses further and (d) shows the condition that the residue of the 1st billet 7 and the 2nd billet 8 became less. That is, it is shown that an activity is continuable until one side of billets 7 and 8 is exhausted.
[0010] this invention person etc. checked in the experiment that the difference according to rank was in the conventional approach and this invention approach so that it may mention later. It decided to form the following assumptions and to explain this difference theoretically. Drawing 3 (a) and (b) are drawings for explaining this invention approach theoretically, and the 1st billet 4 serves as a triangle cross section in the steady state of said drawing 2 (c). This cross section is called a dead metal and that configuration is decided by the property of an ingredient. Then, in drawing 3 (a), when N and the extrusion force of a stem are set to P for the upward force which met theta and this slant-face 4a in the tilt angle of slant-face 4a of the 1st billet 4, the following relational expression is materialized. The tilt angle theta is an include angle which is decided with an ingredient and on which it is easy to slide.
N=P-costheta ... ** [0011] In drawing 3 (b), if it supposes that a part of 1st billet 7 is torn off by the shearing force of the 2nd billet 8 and the cross section of the part torn off by tau and Force N along with slant-face 4a in the critical shear stress at that time is set to A, the following formula will be materialized. In addition, critical shear stress tau is a value decided by the presentation of an ingredient, temperature, etc.
N=tau-A ... In a ** above-mentioned ** type and ** type, tau becomes fixed to costheta under the conditions. Moreover, the following formula is materialized from ** type and ** type.
P-cos theta=tau-A ... **A=(cos theta/tau) -P ... In ** type **, since (cos theta/tau) is fixed, by changing P, A can be changed and the thickness of epidermis can be changed by changing A. In addition, the above explanation is an assumption and makes the below-mentioned experimental value forward to the last.
[0012] The concrete approach of changing P was examined based on the above-mentioned assumption. Drawing 4 (a) (a) shows the example of a comparison, bearing 3A at this time is straight bearing, - (d) is drawing showing this invention approach example and the example of a comparison, and die length is [the path of that is d and] l. (b) shows the 1st example and sets the die length of bearing 3B to L larger enough than that of the example of a comparison. Supposing it extrudes since resistance increases, and it does not change a rate, the extrusion force P will increase, consequently the thickness of epidermis will increase it. (c) shows the 2nd example and sets the path of bearing 3C to D smaller than that of the example of a comparison. Supposing it extrudes since resistance increases, and it does not change a rate, the extrusion force P will increase, consequently the thickness of epidermis will increase it. Since the path of bearing 3C is changed seting the path of a container as constant, it means changing an extrusion ratio in this case.
[0013] Although (d) shows the 3rd example, tapers off, and uses bearing 3D as the taper bearing of a configuration and the tilt angle is called choke angle, the choke angle alpha is given suitably. Although the choke angle of the example of a comparison is 0, if the choke angle alpha is given as shown in drawing, since bearing 3D will taper off and it will become a configuration, supposing it extrudes since resistance increases and does not change a rate, the extrusion force P will increase, consequently the thickness of epidermis will increase it. In addition, since resistance

will increase if the passing speed of a stem is gathered in the structure of (a) as the 4th example, the extrusion force P increases, consequently the thickness of epidermis increases it. In this case, it means changing an extrusion rate.

[Example] The example of this invention is explained below. In addition, bearing points out the part which actually fabricates an ingredient in the hole prepared in the die. Moreover, an extrusion ratio is the value which **(ed) the billet cross section with the product cross section as stated previously. Drawing 5 is a graph concerning the 1st example of this invention, an axis of abscissa is bearing die length, and an axis of ordinate is a clad ratio (%). A clad ratio (%) is prescribed by x(skin-depth (mm) / clad plate radius (mm)) 100.

The 1st example: Bearing die length was changed gradually and the clad ratio at that time (%) was investigated as said drawing 4 (b) explained. Experimental conditions are the 1st billet for epidermis as the table showed to the bottom half part of drawing. Aluminum material The 2nd billet for 6063 core parts Aluminum material 4032 billet temperature 450-degree-C choke angle 0-degree extrusion ratio 24 extrusion rate 30 m/min (stem speed)

The skin depth can be changed by changing bearing die length so that clearly from a graph. However, bearing die length influences shaping of an ingredient directly, and makes the skin depth increase linearly. However, when bearing die length becomes long too much, contact friction becomes excessive and there is a possibility that epidermis may fracture by this frictional force. Then, bearing die length makes about 15mm an upper limit.

[0015] Drawing 6 is a graph concerning the 2nd example of this invention, an axis of abscissa is an extrusion ratio and an axis of ordinate is a clad ratio (%).

The 2nd example: The extrusion ratio was changed gradually and the clad ratio at that time (%) was investigated as said drawing 4 (c) explained. Experimental conditions are the 1st billet for epidermis as the table showed to the bottom half part of drawing. Aluminum material The 2nd billet for 6063 core parts Aluminum material 4032 billet temperature 450-degree-C bearing die length 5mm choke angle 0-degree extrusion rate 400 mm/min (clad plate rate)

The skin depth can be changed by changing an extrusion ratio so that clearly from a graph. However, if an extrusion ratio is enlarged, bending of metal mold, especially a die will become large, and will influence the dimensional accuracy of a product. Then, if an extrusion ratio is in a large-sized billet and it is in 50 and a small billet, it makes 100 an upper limit.

[0016] Drawing 7 is a graph concerning the 3rd example of this invention, an axis of abscissa is a choke angle and an axis of ordinate is a clad ratio (%).

The 3rd example: The choke angle was changed gradually and the clad ratio at that time (%) was investigated as said drawing 4 (d) explained. Experimental conditions are the 1st billet for epidermis as the table showed to the bottom half part of drawing. Aluminum material The 2nd billet for 6063 core parts Aluminum material 4032 billet temperature 450-degree-C bearing die length 3mm extrusion ratio 24 extrusion rate 30 m/min (stem speed)

The skin depth can be changed by changing a choke angle so that clearly from a graph. However, if a choke angle exceeds 0.5 degrees, the skin depth will not become not much thick. On the contrary, since it is hard to take out process tolerance with 0.5 degrees or less, it is desirable to set bearing die length to 2-3mm at 10-15 degrees rather.

[0017] Drawing 8 is a graph concerning the 4th example of this invention, an axis of abscissa is an extrusion rate and an axis of ordinate is a clad ratio (%).

The 4th example: The extrusion rate was changed gradually and the clad ratio at that time (%) was investigated. Modification of an extrusion rate should just change the passing speed of a stem. Experimental conditions are the 1st billet for epidermis as the table showed to the bottom half part of drawing. Aluminum material The 2nd billet for 6063 core parts Aluminum material 4032 choke angles 0-degree billet temperature 450-degree-C bearing die length 5mm extrusion ratio The skin depth can be changed by changing an extrusion rate so that clearly from 24 graphs. However, even if it makes an extrusion rate high, the increment in the skin depth is not like it, either. On the contrary, there is a possibility that generation of heat by friction at bearing may become remarkable, and the configuration of epidermis may worsen. Then, let 60 m/min be upper limits by the aluminum material 6063.

[0018] What is necessary is just to change the skin depth combining one sort or plurality of the above-mentioned example. It is desirable for it to be more effective and to combine other examples with example 1 independent one or an example 1 from the ability of the method of changing the bearing die length of an example 1 to control independently the both sides of productivity and workmanship precision especially. Moreover, if billet temperature is changed, the drag force in bearing will change and compressive force will change according to it. Then, it is also possible to change a billet ratio by combining with a billet temperature independent or the above-mentioned place factor.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The principle Fig. of the manufacture approach of the clad plate by the extrusion method concerning this invention
[Drawing 2] The production process Fig. of the clad plate concerning this invention
[Drawing 3] Drawing for explaining this invention approach theoretically
[Drawing 4] Drawing showing this invention approach example and the example of a comparison
[Drawing 5] The graph concerning the 1st example of this invention
[Drawing 6] The graph concerning the 2nd example of this invention
[Drawing 7] The graph concerning the 3rd example of this invention
[Drawing 8] The graph concerning the 4th example of this invention
[Description of Notations]
1 [-- A die, 5 / -- A stem, 7 / -- The 1st billet for epidermis 8 / -- The 2nd billet for core parts 9 / -- A clad plate, P / -- Compressive force.] -- The extrusion equipment of a clad plate, 2 -- A container, 3 -- Bearing, 4

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to amelioration of the manufacture approach of the clad plate by the extrusion method.
[0002]
[Description of the Prior Art] A clad plate is the layered product of the ingredient with which properties differ, and is manufactured for the purpose of raising the functional characteristic of a member by carrying out the laminating of a jointing material for corrugated fibreboard, corrosion-resistant material, the vibration resistance material, etc. to a front face. Various utilization is carried out at the manufacture approach, one approach in it extrudes, and it is law.
[0003] JP,3-138017,A "the manufacture approach of a solid clad plate" is released to the technique which extrudes a clad plate and is manufactured by law. The billet for core part formation of the shape of a cylinder by which, as for this technique, the projected part for fitting of the letter of a protrusion was really formed in the center of a front end side, The solid die by which the back end side was formed in the concave conical surface performs extrusion using the billet for epidermination of the shape of a ring by which fitting is carried out to this projected part for fitting, and the inclination of the conical surface of the dice back end is used for configuration member ******. By making it move to a shaping hole quantitatively, it is the technique of telling a longitudinal direction that the thickness of epidermis can do uniformly.
[0004]
[Problem(s) to be Solved by the Invention] However, since it uses the inclination of dice ****, the above-mentioned technique tends to involve in epidermis, and when defects, such as a crack, are shown in epidermis, it will produce a streak (****), the part, i.e., the epidermis, by which the clad was carried out. Moreover, in order to prevent it, it is necessary to carry out removal processing of the epidermis by constant-rate cutting etc. from a front face. Therefore, it is the cause of deterioration of the quality of a clad plate, or a cost rise. Furthermore, with the above-mentioned technique, the configuration of a billet is complicated and the degree of freedom of a configuration is restricted.
[0005] Moreover, the above-mentioned technique is a technique which makes thickness of epidermis uniform, and has not mentioned the technique of changing the thickness of epidermis. However, it is necessary to change the clad ratio which shows the thickness rate of epidermis if needed, and to also advance this research in recent years. Then, the purpose of this invention is to attain the simplification of the configuration of a billet and offer the technique which can change a clad ratio.
[0006]
[Means for Solving the Problem] It is characterized by to change a clad ratio by allotting the 2nd billet which this invention allots the 1st billet which serves as epidermis of a clad plate at the dice side in a container in the manufacture approach of the clad plate which compressive force is made to act on two kinds of billets allotted in the container through a stem, and is extruded from bearing, and connects [billet / this / 1st] it in order to solve the above-mentioned technical problem, and serves as a core part, and changing said compressive force.
[0007] Said compressive force is characterized by being set up by at least one chosen from the choke angle which

the die length of the bearing equivalent to a die hole and bearing taper off, and is equivalent to the tilt angle in the case of being a configuration, the extrusion ratio computed with the billet cross section / product cross section, and the extrusion rate.

[0008]

[Function] Drawing 1 (a) and (b) are the principle Figs. of the manufacture approach of the clad plate by the extrusion method concerning this invention, and the extrusion equipment 1 for enforcing this invention approach consists of a container 2, a die 4 which formed bearing 3, and a plunger or a stem 5. By (a), a container 2 is loaded with the 1st billet 7 for epidermis, and the 2nd billet 8 for core parts at this order. The billets 7 and 8 with which it loaded by (b) are pressed by the stem 5.

[0009] Drawing 2 (a) - (d) is the production process Fig. of the clad plate concerning this invention. By having been pushed by the stem 5 by (a), a part of 1st billet 7 is protruded from bearing 3, and, only in the part, the center of a front face of the 2nd billet 8 bulges to the front gradually. By (b), a part of 2nd billet 8 advances into the core of the 1st billet 7 greatly. An arrow head shows the flow of metal notionally among drawing. (c) shows a steady state and the clad plate 9 which the epidermis by the 1st billet 7 covered to the core part by the 2nd billet 8 is extruded from bearing 3. An activity progresses further and (d) shows the condition that the residue of the 1st billet 7 and the 2nd billet 8 became less. That is, it is shown that an activity is continuable until one side of billets 7 and 8 is exhausted.

[0010] this invention person etc. checked in the experiment that the difference according to rank was in the conventional approach and this invention approach so that it may mention later. It decided to form the following assumptions and to explain this difference theoretically. Drawing 3 (a) and (b) are drawings for explaining this invention approach theoretically, and the 1st billet 4 serves as a triangle cross section in the steady state of said drawing 2 (c). This cross section is called a dead metal and that configuration is decided by the property of an ingredient. Then, in drawing 3 (a), when N and the extrusion force of a stem are set to P for the upward force which met theta and this slant-face 4a in the tilt angle of slant-face 4a of the 1st billet 4, the following relational expression is materialized. The tilt angle theta is an include angle which is decided with an ingredient and on which it is easy to slide.

N=P-costheta ... ** [0011] In drawing 3 (b), if it supposes that a part of 1st billet 7 is torn off by the shearing force of the 2nd billet 8 and the cross section of the part torn off by tau and Force N along with slant-face 4a in the critical shear stress at that time is set to A, the following formula will be materialized. In addition, critical shear stress tau is a value decided by the presentation of an ingredient, temperature, etc.

N=tau-A ... In a ** above-mentioned ** type and ** type, tau becomes fixed to costheta under the conditions. Moreover, the following formula is materialized from ** type and ** type.

P-cos theta=tau-A ... **A=(cos theta/tau) -P ... In ** type **, since (cos theta/tau) is fixed, by changing P, A can be changed and the thickness of epidermis can be changed by changing A. In addition, the above explanation is an assumption and makes the below-mentioned experimental value forward to the last.

[0012] The concrete approach of changing P was examined based on the above-mentioned assumption. Drawing 4 (a) (a) shows the example of a comparison, bearing 3A at this time is straight bearing, - (d) is drawing showing this invention approach example and the example of a comparison, and die length is [the path of that is d and] l. (b) shows the 1st example and sets the die length of bearing 3B to L larger enough than that of the example of a comparison. Supposing it extrudes since resistance increases, and it does not change a rate, the extrusion force P will increase, consequently the thickness of epidermis will increase it. (c) shows the 2nd example and sets the path of bearing 3C to D smaller than that of the example of a comparison. Supposing it extrudes since resistance increases, and it does not change a rate, the extrusion force P will increase, consequently the thickness of epidermis will increase it. Since the path of bearing 3C is changed seting the path of a container as constant, it means changing an extrusion ratio in this case.

[0013] Although (d) shows the 3rd example, tapers off, and uses bearing 3D as the taper bearing of a configuration and the tilt angle is called choke angle, the choke angle alpha is given suitably. Although the choke angle of the example of a comparison is 0, if the choke angle alpha is given as shown in drawing, since bearing 3D will taper off and it will become a configuration, supposing it extrudes since resistance increases and does not change a rate, the extrusion force P will increase, consequently the thickness of epidermis will increase it. In addition, since resistance will increase if the passing speed of a stem is gathered in the structure of (a) as the 4th example, the extrusion force P increases, consequently the thickness of epidermis increases it. In this case, it means changing an extrusion rate.

[0014]

[Example] The example of this invention is explained below. In addition, bearing points out the part which actually fabricates an ingredient in the hole prepared in the die. Moreover, an extrusion ratio is the value which **(ed) the billet cross section with the product cross section as stated previously. Drawing 5 is a graph concerning the 1st example of this invention, an axis of abscissa is bearing die length, and an axis of ordinate is a clad ratio (%). A clad

ratio (%) is prescribed by x(skin-depth (mm) / clad plate radius (mm)) 100.

The 1st example: Bearing die length was changed gradually and the clad ratio at that time (%) was investigated as said drawing 4 (b) explained. Experimental conditions are the 1st billet for epidermis as the table showed to the bottom half part of drawing. Aluminum material The 2nd billet for 6063 core parts Aluminum material 4032 billet temperature 450-degree-C choke angle 0-degree extrusion ratio 24 extrusion rate 30 m/min (stem speed)

The skin depth can be changed by changing bearing die length so that clearly from a graph. However, bearing die length influences shaping of an ingredient directly, and makes the skin depth increase linearly. However, when bearing die length becomes long too much, contact friction becomes excessive and there is a possibility that epidermis may fracture by this frictional force. Then, bearing die length makes about 15mm an upper limit.

[0015] Drawing 6 is a graph concerning the 2nd example of this invention, an axis of abscissa is an extrusion ratio and an axis of ordinate is a clad ratio (%).

The 2nd example: The extrusion ratio was changed gradually and the clad ratio at that time (%) was investigated as said drawing 4 (c) explained. Experimental conditions are the 1st billet for epidermis as the table showed to the bottom half part of drawing. Aluminum material The 2nd billet for 6063 core parts Aluminum material 4032 billet temperature 450-degree-C bearing die length 5mm choke angle 0-degree extrusion rate 400 mm/min (clad plate rate)

The skin depth can be changed by changing an extrusion ratio so that clearly from a graph. However, if an extrusion ratio is enlarged, bending of metal mold, especially a die will become large, and will influence the dimensional accuracy of a product. Then, if an extrusion ratio is in a large-sized billet and it is in 50 and a small billet, it makes 100 an upper limit.

[0016] Drawing 7 is a graph concerning the 3rd example of this invention, an axis of abscissa is a choke angle and an axis of ordinate is a clad ratio (%).

The 3rd example: The choke angle was changed gradually and the clad ratio at that time (%) was investigated as said drawing 4 (d) explained. Experimental conditions are the 1st billet for epidermis as the table showed to the bottom half part of drawing. Aluminum material The 2nd billet for 6063 core parts Aluminum material 4032 billet temperature 450-degree-C bearing die length 3mm extrusion ratio 24 extrusion rate 30 m/min (stem speed)

The skin depth can be changed by changing a choke angle so that clearly from a graph. However, if a choke angle exceeds 0.5 degrees, the skin depth will not become not much thick. On the contrary, since it is hard to take out process tolerance with 0.5 degrees or less, it is desirable to set bearing die length to 2-3mm at 10-15 degrees rather.

[0017] Drawing 8 is a graph concerning the 4th example of this invention, an axis of abscissa is an extrusion rate and an axis of ordinate is a clad ratio (%).

The 4th example: The extrusion rate was changed gradually and the clad ratio at that time (%) was investigated. Modification of an extrusion rate should just change the passing speed of a stem. Experimental conditions are the 1st billet for epidermis as the table showed to the bottom half part of drawing. Aluminum material The 2nd billet for 6063 core parts Aluminum material 4032 choke angles 0-degree billet temperature 450-degree-C bearing die length 5mm extrusion ratio The skin depth can be changed by changing an extrusion rate so that clearly from 24 graphs. However, even if it makes an extrusion rate high, the increment in the skin depth is not like it, either. On the contrary, there is a possibility that generation of heat by friction at bearing may become remarkable, and the configuration of epidermis may worsen. Then, let 60 m/min be upper limits by the aluminum material 6063.

[0018] What is necessary is just to change the skin depth combining one sort or plurality of the above-mentioned example. It is desirable for it to be more effective and to combine other examples with example 1 independent one or an example 1 from the ability of the method of changing the bearing die length of an example 1 to control independently the both sides of productivity and workmanship precision especially. Moreover, if billet temperature is changed, the drag force in bearing will change and compressive force will change according to it. Then, it is also possible to change a billet ratio by combining with a billet temperature independent or the above-mentioned place factor.

[0019]

[Effect of the Invention] This invention demonstrates the following effectiveness by the above-mentioned configuration. In the manufacture approach of the clad plate which claim 1 makes compressive force act on two kinds of billets allotted in the container through a stem, and is extruded from bearing By allotting the 1st billet used as the epidermis of a clad plate to the dice side in a container, allotting the 2nd billet which is connected [billet / this / 1st] and serves as a core part, and changing said compressive force Since it is characterized by changing a clad ratio, there is no need of performing processing according to rank to a billet, and a production cost can be lowered. In addition, since the thickness of epidermis is changed by changing the compressive force which acts on the 2nd billet, it responds to various skin-depth demands simply.

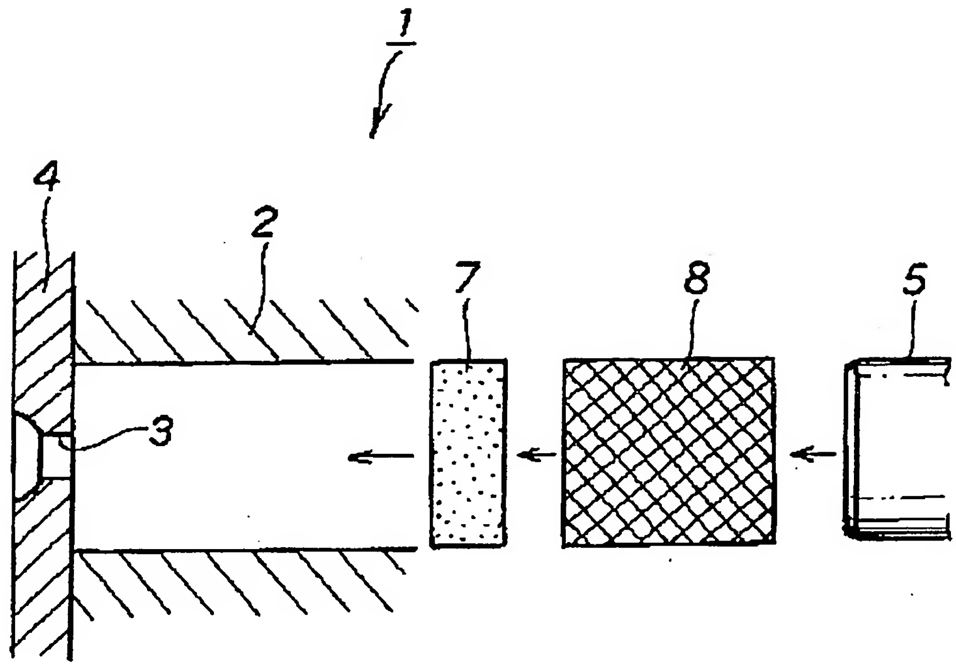
[0020] Since it can change the thickness of epidermis easily since claim 2 set up compressive force by at least one chosen from the choke angle which the die length of the bearing equivalent to a die hole and bearing taper off, and

is equivalent to the tilt angle in the case of be a configuration , the extrusion ratio computed with the billet cross section / product cross section , and the extrusion rate , and manufacture can carry it out very efficiently , fabrication operation becomes easy and an operator's burden becomes light .

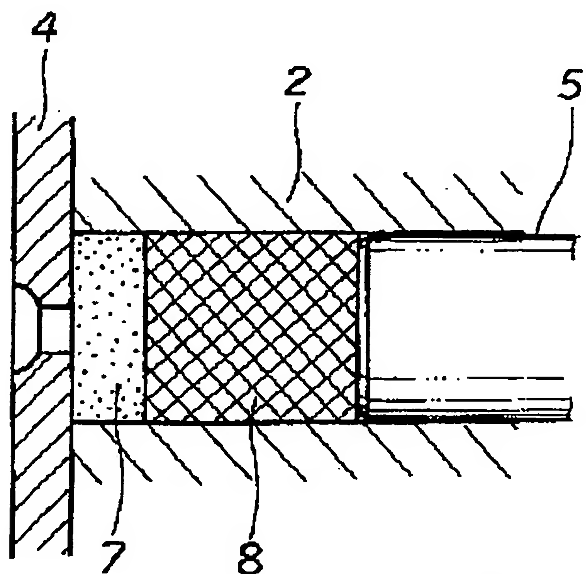
CLAIMS

[Claim(s)]
[Claim 1] The manufacture approach of the clad plate by the extrusion method characterized by to change a clad ratio by making compressive force act on two kinds of billets allotted in the container through a stem, allotting the 1st billet which serves as epidermis of a clad plate at the dice side in a container in the manufacture approach of the clad plate extruded from bearing, allotting the 2nd billet which is connected [billet / this / 1st] and serves as a core part, and changing said compressive force.
[Claim 2] Said compressive force is the manufacture approach of the clad plate by the choke angle which the die length of the bearing equivalent to a die hole and bearing taper off, and is equivalent to the tilt angle in the case of being a configuration, the extrusion ratio computed with the billet cross section / product cross section, and the extrusion method according to claim 1 characterized by being set up by at least one chosen from the extrusion rate.

[Translation done.]



(a)



(b)

(19)日本国特許庁（ＪＰ）　(12) 公開特許公報（Ａ）　(11)特許出願公開番号
特開平8－257629
(43)公開日　平成８年(1996)10月８日

(51)Int.Cl.⁶	識別記号	庁内整理番号	ＦＩ	技術表示箇所
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審査請求　未請求　請求項の数２　ＯＬ　（全７頁）

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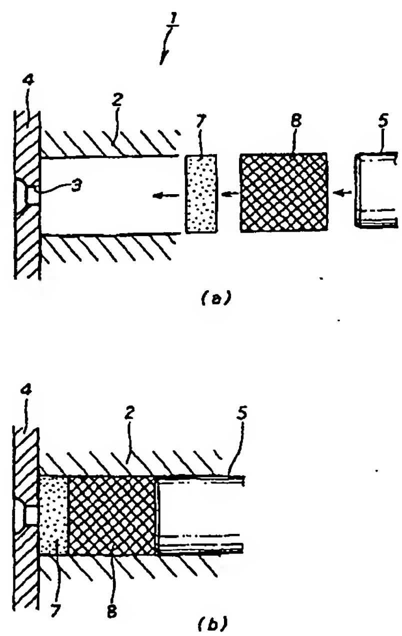
最終頁に続く

(54)【発明の名称】　押出し法によるクラッド材の製造方法

(57)【要約】
【目的】　表皮の厚さを容易に変更でき、しかも高品質を維持できる製造方法を提供する。
【構成】　コンテナ２に表皮用第１ビレット７と芯部用第２ビレット８を押出し方向にこの順に装填し、第２ビレット８をステム５で押出すことにより、表皮と芯部とからなるクラッド材を製造する。この際に第２ビレット８に作用する圧縮力を変化させることにより、表皮の厚さを変更する。



【特許請求の範囲】

【請求項1】　コンテナ内に配した２種類のビレットにステムを介して圧縮力を作用させ、ベアリングより押出すクラッド材の製造方法において、コンテナ内のダイス側にクラッド材の表皮となる第１ビレットを配し、この第１のビレットに連接して芯部となる第２ビレットを配し、前記圧縮力を変化させることにより、クラッド比を変化させることを特徴とする押出し法によるクラッド材の製造方法。

【請求項2】　前記圧縮力は、ダイ孔に相当するベアリングの長さ、ベアリングが先細り形状である場合の傾斜角に相当するチョーク角、ビレット断面積／製品断面積で算出される押出し比、押出し速度から選ばれた少なくとも１つにより設定されることを特徴とする請求項１記載の押出し法によるクラッド材の製造方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は押出し法によるクラッド材の製造方法の改良に関する。

【０００２】

【従来の技術】クラッド材は、性質の異なる材料の積層体であり、表面に接合材、耐食性材、耐振性材などを積層することにより部材の機能特性を向上させることを目的として製造される。その製造方法には各種実用化されており、その中の一方法が押出し法である。

【０００３】クラッド材を押出し法で製造する技術には、例えば、特開平３－１３８０１７号公報「中実クラッド材の製造方法」が公表されている。この技術は、前端面中央に突出状の嵌合用突部が一体形成された円柱状の芯部形成用ビレットと、この嵌合用突部に嵌合されるリング状の表皮形成用ビレットとを用いて、後端面が凹状の錐面に形成されたソリッドダイスにより押出しを行なうものであり、構成部材金属ををダイス後端の錐面の傾斜を利用して、成形孔へ定量的に移動させることにより、表皮の厚さを長手方向に一様にできると言う技術である。

【０００４】

【発明が解決しようとする課題】しかし、上記技術はダイス錐角の傾斜を利用しているため、表皮を巻き込みやすく、表皮に疵等の欠陥がある場合クラッドされた部分即ち表皮にストリーク（筋疵）を生じてしまう。また、それを防止するためには表皮を表面から一定量切削等により除去加工する必要がある。従って、クラッド材の品質の低下、あるいはコストアップの原因となっている。更に、上記技術ではビレットの形状が複雑であり、形状の自由度が制限される。

【０００５】また、上記技術は表皮の厚さを一様にする技術であり、表皮の厚さを変化させる技術には言及していない。しかし、近年、表皮の厚さ割合を示すクラッド比を必要に応じて変化させる必要があり、この研究も進める必要がある。そこで本発明の目的は、ビレットの形状の単純化を図り、且つクラッド比の変更が可能な技術を提供することにある。

【０００６】

【課題を解決するための手段】上記課題を解決するために本発明は、コンテナ内に配した２種類のビレットにステムを介して圧縮力を作用させ、ベアリングより押出すクラッド材の製造方法において、コンテナ内のダイス側にクラッド材の表皮となる第１ビレットを配し、この第１のビレットに連接して芯部となる第２ビレットを配し、前記圧縮力を変化させることにより、クラッド比を変化させることを特徴とする。

【０００７】前記圧縮力は、ダイ孔に相当するベアリングの長さ、ベアリングが先細り形状である場合の傾斜角に相当するチョーク角、ビレット断面積／製品断面積で算出される押出し比、押出し速度から選ばれた少なくとも１つにより設定されることを特徴とする。

【０００８】

【作用】図１（ａ），（ｂ）は本発明に係る押出し法によるクラッド材の製造方法の原理図であり、本発明方法を実施するための押出し装置１は、コンテナ２と、ベアリング３を設けたダイ４と、プランジャ若しくはステム５とからなる。（ａ）にて、コンテナ２に、表皮用第１ビレット７と芯部用第２ビレット８とをこの順に装填する。（ｂ）にて、装填したビレット７，８をステム５で押圧する。

【０００９】図２（ａ）～（ｄ）は本発明に係るクラッド材の製造工程図である。（ａ）にて、ステム５で押されたことにより、第１ビレット７の一部はベアリング３から食み出し、その分だけ第２ビレット８の前面中央が徐々に前方へ膨出する。（ｂ）にて、第１ビレット７の中心に第２ビレット８の一部が大きく進入する。図中、矢印はメタルの流れを概念的に示したものである。（ｃ）は定常状態を示し、ベアリング３からは第２ビレット８による芯部に第１ビレット７による表皮が被ったところのクラッド材９が押出される。（ｄ）は更に作業が進み、第１ビレット７及び第２ビレット８の残量が減った状態を示す。即ち、ビレット７，８の一方が尽きるまでは作業は継続できることを示す。

【００１０】本発明者等は後述するように従来方法と本発明方法に格別の差異があることを実験で確認した。この差異を次のような仮説を立てて理論的に説明することにした。図３（ａ），（ｂ）は本発明方法を理論的に説明するための図であり、前記図２（ｃ）の定常状態では第１ビレット４は三角形断面となる。この断面はデッドメタルと称し、その形状は材料の性質によって決まる。そこで図３（ａ）において、第１ビレット４の斜面４ａの傾斜角をθ、この斜面４ａに沿った押上げ力をＮ、ステムの押出し力をＰとした場合に、次の関係式が成立する。傾斜角θは材料によって決まる滑りやすい角度であ

る。

N＝P・cosθ …①

【0011】図3（b）において、第2ビレット8の剪断力で第1ビレット7の一部が引き剥がされるとし、そのときの臨界剪断応力をτ、力Nによって斜面4aに沿って引き剥がされる部分の断面積をAとすると、次の式が成立する。なお、臨界剪断応力τは材料の組成、温度等によって決まる値である。

N＝τ・A …②

上記①式及び②式において、cosθとτはその条件下で一定となる。また、①式及び②式から次の式が成立する。

P・cosθ＝τ・A …③

A＝（cosθ／τ）・P …④

式④において、（cosθ／τ）が一定であるから、Pを変更することによりAを変更することができ、Aを変えることにより、表皮の厚さを変更することができる。なお、以上の説明は仮説であり、あくまでも後述の実験値を正とする。

【0012】上記仮説に基づいて、Pを変更する具体的方法を検討した。図4（a）～（d）は本発明方法具体例と比較例とを示す図であり、（a）は比較例を示し、このときのベアリング3Aはストレートベアリングであり、それの径はd、長さはlである。（b）は第1実施例を示し、ベアリング3Bの長さを比較例のそれよりも十分に大きいLとしたものである。抵抗が増すので押出し速度を変えないとすると、押出し力Pは増加し、その結果、表皮の厚さは増加する。（c）は第2実施例を示し、ベアリング3Cの径を比較例のそれよりも小さなDとしたものである。抵抗が増すので押出し速度を変えないとすると、押出し力Pは増加し、その結果、表皮の厚さは増加する。コンテナの径を一定としてベアリング3Cの径を変更するので、この場合には、押出し比を変更したことになる。

【0013】（d）は第3実施例を示し、ベアリング3Dを先細り形状のテーパベアリングとし、その傾斜角をチョーク角というが、チョーク角αを適宜もたせるというものである。比較例のチョーク角は0であるが、図のようにチョーク角αをもたせると、ベアリング3Dが先細り形状となるため、抵抗が増すので押出し速度を変えないとすると、押出し力Pは増加し、その結果、表皮の厚さは増加する。その他、第4実施例として（a）の構造において、ステムの移動速度を上げれば抵抗が増すので、押出し力Pは増加し、その結果、表皮の厚さは増加する。この場合は、押出し速度を変更したことになる。

【0014】

【実施例】本発明の実施例を以下に説明する。なお、ベアリングはダイに設けられた孔のなかで、材料を実際に成形する部分を指す。また、先に述べた通り、押出し比はビレット断面積を製品断面積で除した値である。図5は本発明の第1実施例に係るグラフであり、横軸はベアリング長さ、縦軸はクラッド比（%）である。クラッド比（%）は、（表皮厚さ（mm）÷クラッド材半径（mm））×100で規定される。

第1実施例：前記図4（b）で説明した通り、ベアリング長さを段階的に変更して、そのときのクラッド比（%）を調べた。試験の条件は図の下半部分に表で示した通り、

表皮用第1ビレット	アルミニウム材 6063
芯部用第2ビレット	アルミニウム材 4032
ビレット温度	450℃
チョーク角	0°
押出し比	24
押出し速度	30m／min（ステム速度）

グラフから明らかなように、ベアリング長さを変更することで表皮厚さを変更することができる。ただし、ベアリング長さは材料の成形に直接影響し、表皮厚さを直線的に増加させる。しかし、ベアリング長さが長くなり過ぎると、接触摩擦が過大となり、この摩擦力で表皮が破断するおそれがある。そこで、ベアリング長さは15mm程度を上限とする。

【0015】図6は本発明の第2実施例に係るグラフであり、横軸は押出し比、縦軸はクラッド比（%）である。

第2実施例：前記図4（c）で説明した通り、押出し比を段階的に変更して、そのときのクラッド比（%）を調べた。試験の条件は図の下半部分に表で示した通り、

表皮用第1ビレット	アルミニウム材 6063
芯部用第2ビレット	アルミニウム材 4032
ビレット温度	450℃
ベアリング長さ	5mm
チョーク角	0°
押出し速度	400mm／min（クラッド材速度）

グラフから明らかなように、押出し比を変更することで表皮厚さを変更することができる。ただし、押出し比を大きくすると金型、特にダイの撓みが大きくなり、製品の寸法精度に影響する。そこで、押出し比は、大型ビレットにあっては50、小型ビレットにあっては100を上限とする。

【0016】図7は本発明の第3実施例に係るグラフであり、横軸はチョーク角、縦軸はクラッド比（%）である。

第3実施例：前記図4（d）で説明した通り、チョーク角を段階的に変更して、そのときのクラッド比（%）を調べた。試験の条件は図の下半部分に表で示した通り、

表皮用第1ビレット	アルミニウム材 6063
芯部用第2ビレット	アルミニウム材 4032
ビレット温度	450℃
ベアリング長さ	3mm

押出し比　24
押出し速度　30m／min（ステム速度）
グラフから明らかなように、チョーク角を変更することで表皮厚さを変更することができる。ただし、チョーク角は0．5°を越えると表皮厚さはあまり厚くならない。逆に、0．5°以下では加工精度を出しにくいので、むしろ10～15°でベアリング長さを2～3mmとすることが好ましい。

【0017】図8は本発明の第4実施例に係るグラフであり、横軸は押出し速度、縦軸はクラッド比（％）である。

第4実施例：押出し速度を段階的に変更して、そのときのクラッド比（％）を調べた。押出し速度の変更はステムの移動速度を変更するだけでよい。試験の条件は図の下半部分に表で示した通り、
表皮用第1ビレット　アルミニウム材　6063
芯部用第2ビレット　アルミニウム材　4032
チョーク角　0°
ビレット温度　450℃
ベアリング長さ　5mm
押出し比　24
グラフから明らかなように、押出し速度を変更することで表皮厚さを変更することができる。ただし、押出し速度を高くしても表皮厚さの増加はそれ程でもない。逆に、ベアリングでの摩擦による発熱が著しくなり、表皮の形状が悪くなる恐れがある。そこで、アルミニウム材6063で60m／minを上限とする。

【0018】上記実施例の1種又は複数を組合わせて表皮厚さを変更すればよい。中でも、実施例1のベアリング長さを変更する方法が生産性、仕上り精度の双方を独立して制御できることから、より有効であり、実施例1単独又は実施例1に他の実施例を組合わせることが望ましい。また、ビレット温度を変えると、ベアリングにおける抵抗力が変化し、それに応じて圧縮力は変化する。そこで、ビレット温度単独又は上記所因子と組合わせることでビレット比を変更することも可能である。

【0019】

【発明の効果】本発明は上記構成により次の効果を発揮する。請求項1は、コンテナ内に配した2種類のビレットにステムを介して圧縮力を作用させ、ベアリングより押出すクラッド材の製造方法において、コンテナ内のダイス側にクラッド材の表皮となる第1ビレットを配し、この第1のビレットに連接して芯部となる第2ビレットを配し、前記圧縮力を変化させることにより、クラッド比を変化させることを特徴とするものであるから、ビレットに格別の加工を施す必要が無く、生産コストを下げることができる。加えて、第2ビレットに作用する圧縮力を変化させることにより、表皮の厚さを変化させるので、多様な表皮厚さ要求に簡単に応じられる。

【0020】請求項2は、圧縮力を、ダイ孔に相当するベアリングの長さ、ベアリングが先細り形状である場合の傾斜角に相当するチョーク角、ビレット断面積／製品断面積で算出される押出し比、押出し速度から選ばれた少なくとも1つにより設定するようにしたので、容易に表皮の厚さを変更でき、製造が極めて効率的に実施できるので、製造作業が簡単になり、作業者の負担が軽くなる。

【図面の簡単な説明】

【図1】本発明に係る押出し法によるクラッド材の製造方法の原理図

【図2】本発明に係るクラッド材の製造工程図

【図3】本発明方法を理論的に説明するための図

【図4】本発明方法具体例と比較例とを示す図

【図5】本発明の第1実施例に係るグラフ

【図6】本発明の第2実施例に係るグラフ

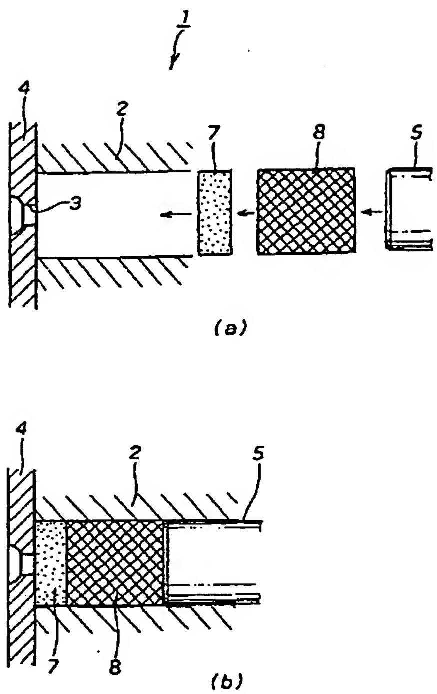
【図7】本発明の第3実施例に係るグラフ

【図8】本発明の第4実施例に係るグラフ

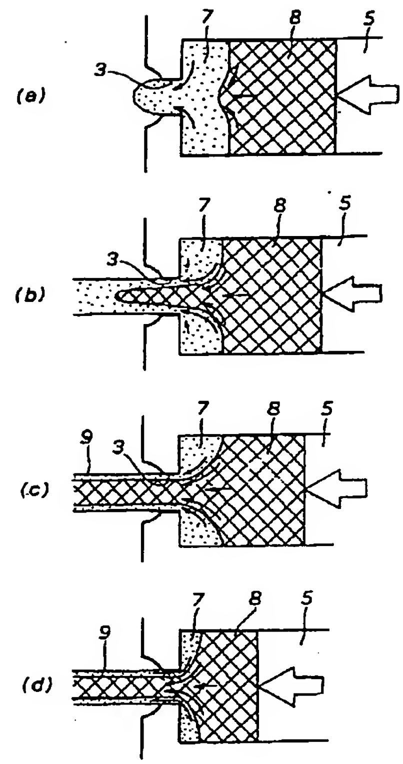
【符号の説明】

1…クラッド材の押出し装置、2…コンテナ、3…ベアリング、4…ダイ、5…ステム、7…表皮用第1ビレット、8…芯部用第2ビレット、9…クラッド材、P…圧縮力。

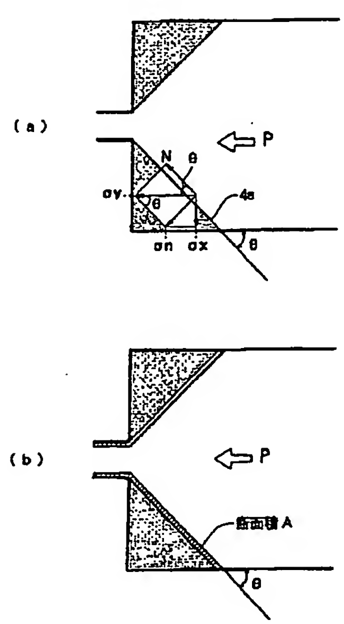
【図1】


1
4
2
7
8
5
3
(a)
4
2
5
7
8
(b)

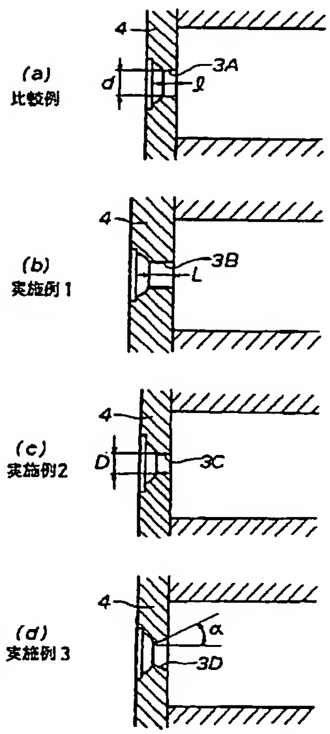
【図2】


7
8
5
3
(a)
7
8
5
3
(b)
7
8
5
9
3
(c)
7
8
5
9
(d)

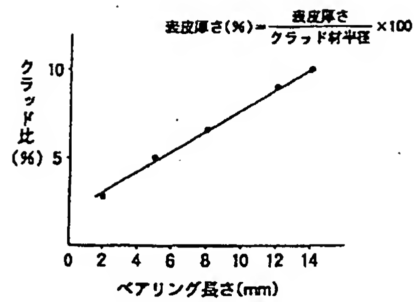
【図3】


(a)
P
N
θ
σy
θ
4a
σn
σx
θ
(b)
P
断面積A
θ

【図4】

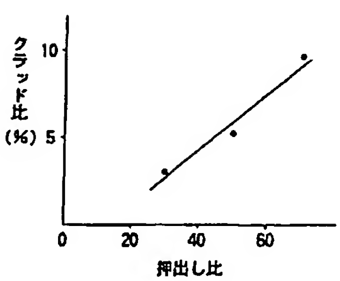


【図5】



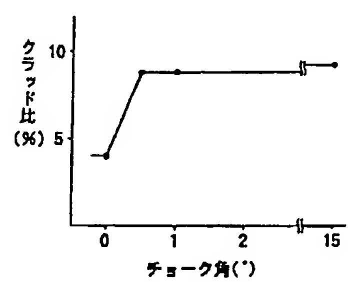
	第1実施例
表皮用第1ビレット	アルミ材　6063
芯部用第2ビレット	アルミ材　4032
ビレット温度	450℃
ベアリング長さ	上記グラフの横軸
チョーク角	0°
押出し比	24
押出し速度	30m／min

【図6】



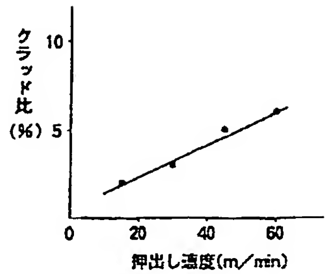
	第2実施例
表皮用第1ビレット	アルミ材　6063
芯部用第2ビレット	アルミ材　4032
ビレット温度	450℃
ベアリング長さ	5mm
チョーク角	0°
押出し比	上記グラフの横軸
押出し速度	400mm／min

【図7】



	第3実施例
表皮用第1ビレット	アルミ材　6063
芯部用第2ビレット	アルミ材　4032
ビレット温度	450℃
ベアリング長さ	3mm
チョーク角	上記グラフの横軸
押出し比	24
押出し速度	30m／min

【図8】



	第4実施例
表皮用第1ビレット	アルミ材　6063
芯部用第2ビレット	アルミ材　4032
ビレット温度	450℃
ベアリング長さ	5mm
チョーク角	0°
押出し比	24
押出し速度	上記グラフの横軸

フロントページの続き

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